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(54) **Electronic identification system**

Elektronisches Erkennungssystem

Système électronique d'identification

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Description

BACKGROUND OF THE INVENTION

This invention relates to an identification system comprising an interrogator and a plurality of transponders.

Interrogator/transponder systems have been used for identifying vehicles, animals, people and other objects. Such systems generally comprise an interrogator comprising a transmitter/receiver and a transponder attached to each object to be identified. The transponder carries a code which uniquely identifies the object in question. Systems of this kind can usually only deal effectively with one transponder at a time. Attempts to mass-produce low cost transponders have generally not been successful, due to the requirement for relatively expensive frequency-critical components in the transponder.

It is an object of the invention to provide transponders which can be produced at a relatively low cost, and an identification system employing such transponders.

PRIOR ART

EP 301127 A discloses an interrogator/transponder system in which the interrogator transmits an interrogation pulse to a transponder. The transponder is "passive", deriving power from an illuminating radio frequency (RF) field via an antenna. The transponder contains an energy accumulator and once the interrogation pulse has ceased the transponder transmits data contained in it's memory. The accumulated energy enables the transponder to repeated transmit the data to increase the probability of successful reception by the interrogator. When a plurality of transponders are present in the interrogation field the interrogation pulse addresses an individual transponder, each transponder having a unique address.

EP 161799 A discloses another interrogator/transponder system in which an interrogator broadcasts an interrogation signal to a plurality of transponders present in the interrogation field. Each transponder transmits a reply signal consisting of a uniquely coded identification number. The interrogator the re-transmit the signal it has received and each transponder decodes the signal and checks the data against it's own identification number. In the event that a particular transponder recognizes it's own code, that transponder discontinues the reply signal or adjusts to receive further instructions (all others having shut down). If interference occurs because two or more transponders are transmitting at the same time, the interrogator waits until a valid signal is received.

GB 2116808 discloses yet another interrogator/transponder system in which an interrogator broadcasts an interrogation signal to a plurality of transponders present in the interrogation field. The transponders repeated transmit a reply signal to increase the probability of successful reception by the interrogator. Each transponders has means for varying in a pseudo-random manner the intervals between successive responses.

EP 405695 discloses yet another interrogator/transponder system in which an interrogator broadcasts an interrogation signal to a plurality of transponders present in the interrogation field. In order to avoid contention between two transponders which overlap when transmitting a response signal, each transponder contains an internal counter which is "scrambled" (i.e. given a random number) by the interrogator. These counts count down to zero and then transmit a starting block. The interrogator, on receipt of a signal from any of the transponders changes the frequency of the of the interrogation signal. All transponders in which the counter has not reached zero are temporarily disabled and any remaining transponders are re-scrambled. The process is repeated until the interrogator receives and recognizes a starting block, indicating that only one transponder remains enabled. Communication with the selected transponder can then be effected. When the communication is completed the transponder is turned off and the selection procedure is recommenced, with all temporarily disabled transponders being re-activated. Each transponder contains a unique identification number which is used in the generation of the random number.

SUMMARY OF THE INVENTION

According to the invention there is provided an identification system comprising an interrogator and a plurality of transponders, the interrogator including transmitter means for transmitting an interrogation signal to the transponders, receiver means for receiving response signals from the transponders, and processor means for identifying transponders from data in the response signals, each transponder comprising a receiving antenna for receiving the interrogation signal, a code generator, a transmitting antenna, and a modulator connected to the code generator, so that on receipt of the interrogation signal the transponder transmits a response signal containing data which identifies the transponder, the transponder being adapted to repeat the transmission of the response signal to increase the probability of successful reception thereof by the interrogator characterised in that the interrogator is adapted to detect successful identification of any transponder and to interrupt the interrogation signal for a predetermined period of time to indicate successful identification.

Preferably, each transponder is adapted to sense the interruption in the interrogation signal and to cease transmission of its response signal in response thereto.

The invention extends to a transponder for use with the identification system, the transponder comprising a receiving antenna for receiving an interrogation signal, a code generator, a transmitting antenna, and a modulator connected to the code generator, the, transponder being adapted to transmit a response signal containing data which identifies the transponder, the transponder including control means arranged to cause repeated transmission of the response signal to increase the probability of successful reception thereof by the interrogator.

Preferably, the control means is arranged to monitor the received interrogation signal and to disable the modulator on receipt of a predetermined confirmation signal from the interrogator which is received after successful reception of the response signal by the interrogator.

In one version of the transponder the modulator is arranged to divert a portion of the energy of the received interrogation signal to the transmitting antenna, so that on receipt of the interrogation signal, the transponder transmits a response signal comprising a carrier derived from the interrogation signal which is modulated by the output of the code generator.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1	is a simplified block diagram showing an interrogator (reader) and a transponder according to the invention;
Figure 2	is a simplified block diagram of the interrogator of Figure 1;
Figure 3	is a schematic diagram of the amplifier and comparator of the interrogator of Figures 1 and 2;
Figure 4	is a block diagram of a transponder according to the invention;
Figure 5	is a timing diagram illustrating the operation of the interrogator and three transponders;
Figure 6	is a simplified flow chart illustrating the operation of the interrogator;
Figure 7	is a simplified flow chart illustrating the operation of each transponder;
Figures 8 and 9	are schematic illustrations of two applications of the invention;
Figure 10	is a functional block diagram of an integrated circuit employed in the transponder;
Figure 11	is a circuit diagram of an embodiment of the transponder;
Figures 12 and 13	are typical waveforms generated by the transponder and interrogator; and
Figure 14	is a table showing the response of the integrated circuit of Figure 10 to different control signals.

DESCRIPTION OF EMBODIMENTS

Figure 1 illustrates, in a very simplified form, an interrogator (reader) interacting with a transponder according to the invention. Figure 2 illustrates the basic circuitry of the interrogator in greater detail.

The interrogator includes a transmitter 10 which transmits a 915 MHz interrogation signal at a power of approximately 15 W via a transmitting antenna 12. The transponder receives the interrogation signal and responds with a much weaker response signal at the same frequency, which is modulated with a code identifying the transponder and thus the object with which the transponder is associated. (Operation of the transponder is described below.)

The response signal from the transponder is received by a receiving antenna 14 of the interrogator and passed through a microstrip directional coupler 16, which attenuates excessively strong received signals, to an amplifier 18, before being fed to a mixer 20. The received signal has a carrier frequency which is the same as the transmitting frequency of the interrogator. The amplified received signal is mixed with a reference sample from the transmitter 10, and the resulting low frequency output is passed through a bandpass filter 22 and thence to an amplifier 24 and a comparator or threshold detector 26. The comparator squares the amplified output of the bandpass filter, so that its output is a digitally compatible output waveform containing the code transmitted by the transponder. One possible embodiment of a circuit block including the amplifier 24 and the comparator 26 is shown in Figure 3. This output signal is fed to a microprocessor 28 which analyses the received code and checks its validity using conventional circular redundancy checking systems, before outputting the code for further processing.

It will be noted that the amplifier has a second input for use with a second receiver channel. This input is for use in a version of the transponder with a spatial diversity antenna arrangement, in which two otherwise identical receiving antennas are spaced apart by one half wavelength. This ensures that if one antenna does not receive the interrogation signal adequately strongly, due for example to standing wave effects or the like, the second antenna will receive the interrogation signal. This improves the reliability of operation of the transponder system.

The microprocessor 28 is arranged to control the transmitter 10 to interrupt the output of the transmitter immediately after receipt of a valid identification code from a transponder. For example, immediately after receipt of a valid transmission from any transponder, the microprocessor shuts off the transmitter 10 for a brief period, say one millisecond.

Figure 4 illustrates the transponder itself. The transponder includes a receiving antenna 30 and a transmitting antenna 32 which are typically defined by a printed circuit. The antennas 30 and 32 are cross polarised to minimise crosstalk. The receiving antenna is connected via a diode 34 to a charge storage device in the form of a capacitor C, which stores a portion of the energy of the interrogation signal received by the receiving antenna. When the capacitor C has charged sufficiently, it enables an integrated circuit code generator 36, which is preprogrammed with a unique code which is transmitted three times at approximately 1 200 baud. The output signal from the code generator is fed via a flipflop 38 to a modulator 40 which re-directs a portion of the energy received via the receiving antenna 30 to the transmitting antenna 32. The flipflop 38 is controlled by a logic circuit 40.

Because the modulator 40 uses the received interrogation signal as the transmitter source for its output carrier signal, no frequency critical components are required, as would be the case with an actively powered transmitter and modulator circuit. Thus, the transponder can comprise a circuit board on which the receiving and transmitting antennas 30 and 32 are printed, together with one or more integrated circuits providing charge storage, code generation and modulating functions. It is also possible to combine the transmitting and receiving antennas in a single antenna. The modulator 40 is typically a diode which is reverse biased and which is biased into a conducting mode by pulses from the code generator to allow energy transfer from the receiving antenna 30 to the transmitting antenna 32.

Obviously, the receiving antenna 14 of the interrogator receives a strong component of the interrogation signal transmitted by its transmitting antenna 12. However, in view of the fact that mixing of two identical frequency components gives a DC component in the mixer, it is a relatively simple matter to remove this component by means of the bandpass filter 22, so that the received code is not contaminated. Thus, simultaneous transmission and reception on the same frequency is possible, as well as the use of a highly simplified transponder circuit.

In an alternative version of the transponder, the transponder is provided with its own power supply, such as a battery, and can therefore use an input amplifier to improve its sensitivity. This allows the interrogator to transmit at a significantly lower power, for example, at 100 mW instead of 15 W. This is because the interrogation signal does not need to contain sufficient energy to power the transponder in this application. A transmitting power of 100 mW has been found to be adequate for a reading distance of 4m. However, the embodiment illustrated in Figure 4 is particularly advantageous, due to its compatibility with ultra low cost mass production techniques, which facilitates multiple article identification as described below.

When the interrogator receives response signals from several transponders which have been interrogated at the same time, it will occur from time to time that two or more transponders are transmitting during the same period, notwithstanding the fact that there is a random or pseudo-random delay between transmissions from each transponder, so that the transponders effectively 'Jam" each other. This will generally prevent correct reception of the code transmitted by either transponder. However, provided that the codes transmitted by the transponders are fixed in length and include error correction bits, such as CRC codes, it is possible for the interrogator to confirm whether or not it has received a valid code. As mentioned above, as soon as a code is validly received, the interrogation signal is interrupted briefly, for a period shorter than the length of a transponder transmission.

The logic circuit 42 in each transponder monitors the presence of the interrogation signal at the output of the receiving antenna 30. As soon as the logic circuit detects the interruption in the interrogation signal following on the completion of the last transmission by the transponder, the flipflop 38 is set, disabling the modulator 40 and thus stopping the transmission from that transponder.

The timing diagram of Figure 5 illustrates the interaction of the interrogator and three transponders, while the flow charts of Figures 6 and 7 illustrate the sequence of operation of the interrogator and the transponders, respectively.

The effect of the above arrangement is that each transponder ceases to transmit as soon as it has successfully transmitted its identification code to the interrogator. As each transponder shuts down, more interference-free time is created within which other transponders in a group of such transponders can transmit their signals to the interrogator. This process continues until all of the transponders have successfully transmitted their identification code to the interrogator. The microprocessor can count the number of transponders identified.

Assuming that all transponders have the same identification code, it is thus possible for the interrogator to count the number of transponders which respond to the interrogation signal in a particular time period. For example, a large number of identical articles can each be provided with a transponder, all the transponders having the same identification code, and a portable interrogator unit can be used to count the articles. This can be done, for example, in a warehouse or other storage area, and obviates the necessity for physically counting stock. The transponders can be fitted to individual articles, or to containers such as boxes, each of which contains a known number of articles. It will be appreciated that it is not even necessary for the articles which are fitted with transponders to be visible for them to be counted in this way. Conveniently, the antennas 30 and 32 (or a single dual-purpose antenna) can be printed on a surface of the container using conductive ink, while the electronic circuitry of the transponder is secured to the surface in electrical contact with the antenna(s). Such an embodiment can be produced very inexpensively using the passive transponder embodiment described above, making it possible to use the transponders in an automatic stock control system for relatively low cost articles.

Because of the low cost of the passive transponders, it is proposed, eventually, that a transponder can be attached to each item of stock in a supermarket, for example, so that a trolley full of groceries can be scanned automatically by an interrogator located at a till, without any handling of the goods by a cashier being required. This is possible because the invention makes it possible both to identify each item in a group of different items, as well as to count the number of each type of item present. Obviously, the cost of the transponders would determine the value of the articles to which they can viably be applied. However, with present day technology, the transponders can be produced at a cost low enough for them to be used economically with medium-priced articles such as domestic appliances, applied to disposable packaging.

In a inner development of the invention, the interrogation signal can be modulated intermittently with a code signal corresponding to the identity of one or more transponders, or a designated class of transponders, which are being sought. The logic circuit 42 of each transponder then checks the transmitted code in the interrogation signal, and activates the transponder only if it is one of those transponders corresponding to the transmitted code. Other transponders remain disabled. Once all transponders in a particular category have been identified and/or counted, the interrogation signal is removed to allow the charge storage device in the transponders to discharge, and the code in the interrogation signal is then be changed to allow a new category of transponders to be interrogated.

Two further applications of the transponder are schematically illustrated in Figures 8 and 9. The application illustrated in Figure 8 is for vehicle identification, where one vehicle or several vehicles can be identified at a time. In the application illustrated schematically in Figure 9, the system is used to identify the members of a group of people, who may pass the interrogator simultaneously. In conventional systems, simultaneous interrogation of a number of transponders would result in simultaneous transmission from the transponders, making it impossible to read the transmitted data. However, the code generator of each transponder transmits its unique code three times, with a spacing between transmissions which is pseudo-randomly determined based on the identification code of that transponder itself. This assists in allowing each transponder to have a "quiet time" when it is the only unit radiating.

Another application for the transponders is in identifying personnel, as shown in Figure 9. Tests have been conducted in which transponders according to the invention were fitted to the battery boxes of miner's cap lamps. In this case, powered versions of the transponders were used, due to the ready availability of battery power. Interrogators are placed at desired locations, for example at the entrances to mine haulages or stopes, and can count personnel entering demarcated areas, as well as identifying each person individually. The individual interrogators are connected to a central computer, which can monitor the movement of personnel in the mine, and which can generate a map or other display, if required, indicating the location of each individual. This is particularly useful in emergencies, allowing rescue parties to know how many individuals are trapped in a certain area after a rock fall, for example.

A prototype system, employing a 915 MHz interrogation signal of 15 W, can effectively read transponders in the form of badges the size of a credit card at a distance of approximately 4 m. 64 bit identification codes were used in the prototype, allowing a large number of uniquely identified transponders to be provided.

A prototype of the transponder was developed using two custom made integrated circuits IC1 and IC2. The first integrated circuit, ICI, is designated type CLA 61061 and is a CMOS Manchester encoder with a pseudo random delay function. This device is designed for the serial transmission of either a 64 bit or a 128 bit word in Manchester 11 format, at pseudo random intervals. The chip also provides addressing for a memory device in which the word to be transmitted (that is, the identification code) is stored, and logic control of the timing sequence of operation.

The integrated circuit IC2 is designated type */047 and comprises a bipolar analogue PROM, an oscillator, and a power-on-reset circuit on a single chip. The chip also includes a "gap detector" circuit and circuitry for rectifying and modulating an RF carrier. The RF circuitry can be bypassed in part or completely, to make use of special high frequency rectifying diodes. The PROM is a 64 bit memory implemented with aluminium fuses which are selectively blown before packaging of the chip, to store a selected identification code.

Figure 10 is a functional block diagram of the integrated circuit IC1, and Figure 11 illustrates one possible implementation of a transponder using the two integrated circuits. In Figure 11, a capacitor C_{gap} is provided for systems in which the transponder waits for a "gap" or quiet period before responding to an interrogation signal.

In Figure 12, the RFC pulse train includes a set of synchronisation pulses, which can be omitted in applications where it is necessary to save time, or where the coding of the received signal is performed in software (see Figure 13).

On start-up of the integrated circuit IC1, the memory device (IC2) is addressed and the Manchester data sequence is transmitted. The internal pseudo random number generator of the chip 1C2 is loaded with the last 16 bits of the data in the memory device, which determine a pseudo random time interval before the Manchester sequence is transmitted again. The maximum length of the interval is a multiple of the length of the time taken to transmit one Manchester sequence. The integrated circuit IC1 has a number of control pins which allow its operation to be modified as required. The pins SA and SB (see Figure 11) control the time interval between data transmission, in accordance with the table of Figure 14. In Figure 14, each "slot" referred to in the third column of the table is equal to the length of a single Manchester sequence transmission.

Start-up ofthe integrated circuit IC1 can be initiated in one of two ways, determined by the status of the pin GAP. In the first mode, operation starts as soon as the RESET pin goes low, while in the second mode, operation starts after the RESET pin goes low and a rising edge is presented to the ENV pin. This is used to delay transmission from the transponder until a low-going pulse has been presented to the ENV pin by the logic circuit 42, which provides the "gap detection" or "quiet period" detection function referred to above.

The status of the pin MM determines the appearance of the Manchester sequence. If the pin MM is high, the data in the memory device is transmitted as a simple sequence of Manchester bits with no synchronisation pulses. With the pin MM low, the Manchester sequence starts with eight Manchester 0's for synchronisation and a command synchronisation sequence before transmitting the data bytes. The pin EK, when high, enables the termination of transmission after three transmissions of the Manchester sequence. If the pin EK is held low, transmission continues until the integrated circuit is powered down or reset. The status of the pin NB determines the length of the sequence that is transmitted. If the pin NB is held low, addressing for 64 bits is provided and 64 bits are transmitted. With the pin NB held high, 128 bits are addressed and transmitted. Both integrated circuits are designed to operate at low voltages of 2V or less, and to draw low currents of less than ImA.

Claims

1. An identification system comprising an interrogator and a plurality of transponders, the interrogator including transmitter means (10) for transmitting an interrogation signal to the transponders, receiver means (16,18,20,22) for receiving response signals from the transponders, and processor means (28) for identifying transponders from data in the response signals each transponder comprising a receiving antenna (30) for receiving the interrogation signal, a code generator (36), a transmitting antenna (32), and a modulator (40) connected to the code generator, so that on receipt of the interrogation signal the transponder transmits a response signal containing data which identifies the transponder, the transponder being adapted to repeat the transmission of the response signal to increase the probability of successful reception thereof by the interrogator characterised in that the interrogator is adapted to detect successful identification of any transponder and to interrupt the interrogation signal to indicate successful identification.

2. An identification system according to claim 1 characterised in that each transponder includes means (38,42) responsive to a respective interruption of the interrogation signal.

3. An identification system according to claim 2 characterised in that the interrogator is adapted to interrupt the interrogation signal for a predetermined period after successfully identifying a particular transponder, that transponder in turn being adapted to sense the interruption in the interrogation signal and to cease transmission of its response signal in response thereto.

4. An identification system according to claim 3 characterised in that the predetermined period for which the interrogation signal is interrupted is shorter than the response signal of the transponder.

5. An identification system according to any one of claims 1 to 4 characterised in that the transponder includes control means (42) for controlling the transmission of the response signal, the control means being adapted to cause repeated transmissions of the response signal at predetermined intervals.

6. An identification system according to claim 5 characterised in that the predetermined intervals are random or pseudo-random in length.

7. An identification system according to claim 6 characterised in that the length of the random or pseudo-random intervals is derived from data identifying the transponder.

8. An identification system according to any one of claims 1 to 7 characterised in that the interrogator is adapted to transmit a code identifying a predetermined transponder or category of transponders, each transponder including circuity (42) for enabling the transponder only on receipt of the code corresponding thereto.

9. An identification system according to any one of claims 1 to 8 characterised in that the modulator (40) of each transponder is arranged to divert a portion of the energy of the received interrogation signal to the transmitting antenna, so that on receipt of the interrogation signal, the transponder transmits a response signal comprising a carrier derived from the interrogation signal which is modulated by the output of the code generator (36).

10. An identification system according to claim 9 characterised in that the interrogator includes a mixer (20) for mixing

a reference signal derived from the interrogation signal with the received response signal from the transponder, and filter means (22) for extracting a difference signal from the mixer output which contains the data from the response signal.

11. A transponder comprising a receiving antenna (30) for receiving an interrogation signal, a code generator (36), a transmitting antenna (32), and a modulator (40) connected to the code generator, the transponder being adapted to transmit a response signal containing data which identifies the transponder, the transponder including control means (38.42) arranged to cause repeated transmission of the response signal to increase the probability of successful reception thereof by the interrogator characterised in that the transponder is responsive to an interruption in the interrogation signal.

12. A transponder according to claim 11 characterised in that the control means (42) is responsive to the interruption of the interrogation signal to cease transmission of the response signal.

13. A transponder according to claim 11 or claim 12 characterised in that the modulator (40) is arranged to divert a portion of the energy of the received interrogation signal to the transmitting antenna (32), so that on receipt of the interrogation signal, the transponder transmits a response signal comprising a carrier derived from the interrogation signal which is modulated by the output of the code generator (36).

14. A transponder according to claim 12 or claim 13 characterised in that the control means (38,42) is arranged to monitor the received interrogation signal and to disable the modulator (40) on receipt of a predetermined confirmation signal from the interrogator which is received after successful reception of the response signal by the interrogator.

15. A transponder according to claim 14 characterised in that the control means (42) is adapted to detect an interruption of the interrogation signal of a predetermined period.

16. A transponder according to any one of claims 11 to 15 including charge storage means (c) arranged to store a portion of the energy of the interrogation signal, at least the code generator (36) being arranged to be powered by the charge storage means in operation.

17. A transponder according to any one of claims 14 to 16 characterised in that the control means (42) is adapted to monitor the received interrogation signal for a predetermined code, and to enable the modulator (40) only on receipt of that code.

18. A transponder according to any one of claims 11 to 17 characterised in that at least one of the receiving and transmitting antennas (30,32) is formed on a substrate to which the transponder is applied.

19. A transponder according to claim 18 characterised in that at least one antenna (30,32) is formed by printing on the substrate with a conductive material.

20. A transponder according to any one of claims 11 to 19 characterised in that the control means (38,42) is adapted to cause repeated transmission of the response signal at predetermined intervals.

21. A transponder according to claim 20 characterised in that the predetermined intervals are random or pseudo-random in length.

22. A transponder according to claim 21 characterised in that thc length of the random or pseudo-random intervals is derived from the data identifying the transponder.

23. A transponder according to any one of claims 11 to 22 characterised in that the control means (42) is adapted to monitor the received interrogation signal and to enable transmission of the response signal only after an interruption of the interrogation signal for a predetermined duration.

24. An interrogator for identifying a plurality of transponders comprising transmitter means (10) for transmitting an interrogation signal to the transponders, receiver means (16,18,20,22) for receiving response signals from the transponders, and processor means (28) for identifying a transponder from data in the response signal characterised in that the interrogator is adapted to interrupt the interrogation signal to indicate successful indentification.

25. An interrogator as claimed in claim 24 characterised in that the interrogator is adapted to interrupt the interrogation signal for a predetermined time after successfully identifying a transponder.

26. An interrogator as claimed in claim 24 characterised in that the interrogation signal is modulated with a code corresponding to data stored in at least one of the transponders.

27. A transponder for use with an interrogator as claimed in claim 24 characterised in that the transponder is adapted to sense the interruption in the interrogation signal.

28. A transponder for use with an interrogator as claimed in claim 26 characterised in that the transponder determines the code in the interrogation signal and further characterised in that the transponder transmits a response signal if the transmitted code and the stored data correspond.

29. A transponder for use in the system as claimed in any of claims 1 to 10.

30. An integrated circuit for use in a transponder comprising means for generating a signal, in response to an interrogation signal, containing data which identifies the transponder and control means (38,42) arranged to cause repeated generation of the response signal characterised in that the integrated circuit is responsive to an interruption in the interrogation signal.

31. An integrated circuit according to claim 30 characterised in that the control means (42) is responsive to the interruption of the interrogation signal to cease generation of the response signal.

32. A integrated circuit according to claim 30 characterised in that the control means (42) is adapted to detect an interruption of the interrogation signal of a predetermined period.

33. A integrated circuit according to any one of claims 30 to 32 including charge storage means (c) arranged to store a portion of the energy of the interrogation signal.

34. A integrated circuit according to any one of claims 30 to 33 characterised in that the control means (42) is adapted to monitor the received interrogation signal for a predetermined code, and to enable the control means only on receipt of that code.

35. A integrated circuit according to any one of claims 30 to 34 characterised in that the control means (38,42) is adapted to cause repeated generation of the response signal at predetermined intervals.

36. A integrated circuit according to claim 35 characterised in that the predetermined intervals are random or pseudorandom in length.

37. A integrated circuit according to any one of claims 30 to 34 characterised in that the control means (42) is adapted to monitor the received interrogation signal and to enable generation of the response signal only after an interruption of the interrogation signal for a predetermined duration.

Patentansprüche

1. Identifikationssystem mit einem Interrogator oder einer Abfrageeinheit und einer Vielzahl von Transpondern oder Antworteinheiten, bei dem der Interrogator eine Sendereinrichtung (10) zum Senden eines Abfragesignales zu den Transpondern, Empfängereinrichtungen (16, 18, 20, 22) zum Empfangen von Antwortsignalen von den Transpondern und eine Prozessoreinrichtung (28) zum Identifizieren von Transpondern aus den Daten in den Antwortsignalen aufweist, bei dem jeder Transponder eine Empfangsatenne (30) zum Empfangen des Abfragesignales, einen Codegenerator (36), eine Sendeantenne (32) und einen Modulator (40), der mit dem Codegenerator verbunden ist, aufweist, so daß bei Empfang des Abfragesignales der Transponder ein Antwortsignal sendet, das Daten enthält, die den Transponder identifizieren, wobei der Transponder gestaltet ist, um die Übertragung des Antwortsignales zur Steigerung der Wahrscheinlichkeit eines erfolgreichen Empfanges hiervon durch den Interrogator zu wiederholen, dadurch gekennzeichnet, daß der Interrogator gestaltet ist, um eine erfolgreiche Identifikation irgendeines Transponders zu erfassen und das Abfragesignal zum Anzeigen einer erfolgreichen Identifikation zu unterbrechen.

2. Identifikationssystem nach Anspruch 1, dadurch gekennzeichnet, daß jeder Transponder eine Einrichtung (38, 42) umfaßt, die auf eine jeweilige Unterbrechung des Abfragesignales anspricht.

3. Identifikationssystem nach Anspruch 2, dadurch gekennzeichnet, daß der Interrogator gestaltet ist, um das Abfragesignal für eine vorbestimmte Zeitdauer nach erfolgreichen Identifizieren eines besonderen Transponders zu unterbrechen, wobei dieser Transponder seinerseits gestaltet ist, um die Unterbrechung im Abfragesignal zu erfassen und eine Übertragung von dessen Antwortsignal abhängig hiervon zu beenden.

4. Identifikationssystem nach Anspruch 3, dadurch gekennzeichnet, daß die vorbestimmte Zeitdauer, für die das Abfragesignal unterbrochen ist, kürzer ist als das Antwortsignal des Transponders.

5. Identifikationssystem nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Transponder eine Steuereinrichtung (42) umfaßt, um die Übertragung des Antwortsignales zu steuern, wobei die Steuereinrichtung gestaltet ist, um wiederholte Übertragungen des Antwortsignales zu vorbestimmten Intervallen zu veranlassen.

6. Identifikationssystem nach Anspruch 5, dadurch gekennzeichnet, daß die vorbestimmten Intervalle zufällig oder pseudo-zufällig in der Länge sind.

7. Identifikationssystem nach Anspruch 6, dadurch gekennzeichnet, daß die Länge der zufälligen oder pseudo-zufälligen Intervalle aus Daten abgeleitet ist, die den Transponder identifizieren.

8. Identifikationssystem nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß der Interrogator gestaltet ist, um einen Code zu senden, der einen vorbestimmten Transponder oder eine Kategorie von Transpondern identifiziert, wobei jeder Transponder eine Schaltungsanordnung (42) umfaßt, um den Transponder lediglich bei Empfang des hierzu entsprechenden Codes freizugeben.

9. Identifikationssystem nach einem der Ansprüche 1 bis 8, dadurch gekennzeichnet, daß der Modulator (40) jedes Transponders angeordnet ist, um einen Teil der Energie des empfangenen Abfragesignales zu der Sendeantenne abzuleiten, so daß bei Empfang des Abfragesignales der Transponder ein Antwortsignal mit einem Träger sendet, der aus dem Abfragesignal abgeleitet ist, das durch das Ausgangssignal des Codegenerators (36) moduliert ist.

10. Identifikationssystem nach Anspruch 9, dadurch gekennzeichnet, daß der Interrogator eine Mischstufe (20), um ein aus dem Abfragesignal abgeleitetes Bezugssignal mit dem empfangenen Antwortsignal von dem Transponder zu mischen, und eine Filtereinrichtung (22) zum Aussieben eines Differenzsignales aus dem Mischstufen-Ausgangssignal, das die Daten von dem Antwortsignal enthält, umfaßt.

11. Transponder mit einer Empfangsantenne (30) zum Empfangen eines Abfragesignales, einem Codegenerator (36), einer Sendeantenne (32) und einem mit dem Codegenerator verbundenen Modulator (40), wobei der Transponder gestaltet ist, um ein Antwortsignal zu senden, das Daten enthält, die den Transponder identifizieren, wobei der Transponder eine Steuereinrichtung (38, 42) aufweist, die angeordnet ist, um eine wiederholte Übertragung des Antwortsignales zur Steigerung der Wahrscheinlichkeit eines erfolgreichen Empfanges hiervon durch den Interrogator zu veranlassen, dadurch gekennzeichnet, daß der Transponder auf eine Unterbrechung in dem Abfragesignal anspricht.

12. Transponder nach Anspruch 11, dadurch gekennzeichnet, daß die Steuereinrichtung (42) auf die Unterbrechung des Abfragesignales anspricht, um eine Übertragung des Antwortsignales zu beenden.

13. Transponder nach Anspruch 11 oder 12, dadurch gekennzeichnet, daß der Modulator (40) angeordnet ist, um einen Teil der Energie des empfangenen Abfragesignales zu der Sendeantenne (32) abzuleiten, so daß bei Empfang des Abfragesignales der Transponder ein Antwortsignal mit einem Träger sendet, der aus dem Abfragesignal abgeleitet ist, das durch den Ausgang des Codegenerators (36) moduliert ist.

14. Transponder nach Anspruch 12 oder Anspruch 13, dadurch gekennzeichnet, daß die Steuereinrichtung (38, 42) angeordnet ist, um das empfangene Abfragesignal zu überwachen und den Modulator (40) bei Empfang eines vorbestimmten Bestätigungssignales von dem Interrogator, das nach einem erfolgreichen Empfang des Antwortsignales durch den Interrogator empfangen ist, abzuschalten.

15. Transponder nach Anspruch 14, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um eine

Unterbrechung des Abfragesignales für eine vorbestimmte Zeitdauer zu erfassen.

16. Transponder nach einem der Ansprüche 11 bis 15, mit einer Ladungsspeichereinrichtung (c), die angeordnet ist, um einen Teil der Energie des Abfragesignales zu speichern, wobei wenigstens der Codegenerator (36) angeordnet ist, um durch die Ladungsspeichereinrichtung im Betrieb versorgt zu sein.

17. Transponder nach einem der Ansprüche 14 bis 16, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um das empfangene Abfragesignal auf einem vorbestimmten Code zu überwachen, und um den Modulator (40) nur bei Empfang dieses Codes freizugeben.

18. Transponder nach einem der Ansprüche 11 bis 17, dadurch gekennzeichnet, daß wenigstens eine der Empfangs- und Sendeantennen (30, 32) auf einem Substrat gebildet ist, auf das der Transponder aufgetragen ist.

19. Transponder nach Anspruch 18, dadurch gekennzeichnet, das wenigstens eine Antenne (30, 32) durch Drucken auf dem Substrat mit einem leitenden Material gebildet ist.

20. Transponder nach einem der Ansprüche 11 bis 19, dadurch gekennzeichnet, daß die Steuereinrichtung (38, 42) gestaltet ist, um eine wiederholte Übertragung des Antwortsignales zu vorbestimmten Intervallen zu veranlassen.

21. Transponder nach Anspruch 20, dadurch gekennzeichnet, daß die vorbestimmten Intervalle zufällig oder pseudozufällig in der Länge sind.

22. Transponder nach Anspruch 21, dadurch gekennzeichnet, daß die Länge der zufälligen oder pseudo-zufälligen Intervalle aus den Daten abgeleitet ist, die den Transponder identifizieren.

23. Transponder nach einem der Ansprüche 11 bis 22, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um das empfangene Abfragesignal zu überwachen und eine Übertragung des Antwortsignales nur nach einer Unterbrechung des Abfragesignales für eine vorbestimmte Zeitdauer freizugeben.

24. Interrogator zum Identifizieren einer Vielzahl von Transpondern mit einer Sendereinrichtung (10) zum Senden eines Abfragesignales zu den Transpondern, einer Empfängereinrichtung (16, 18, 20, 22) zum Empfangen von Antwortsignalen von den Transpondern und einer Prozessoreinrichtung (28) zum Identifizieren eines Transponders aus Daten in dem Antwortsignal, dadurch gekennzeichnet, daß der Interrogator gestaltet ist, um das Abfragesignal zum Anzeigen einer erfolgreichen Identifikation zu unterbrechen.

25. Interrogator nach Anspruch 24, dadurch gekennzeichnet, daß der Interrogator gestaltet ist, um das Abfragesignal für eine vorbestimmte Zeit nach einem erfolgreichen Identifizieren eines Transponders zu unterbrechen.

26. Interrogator nach Anspruch 24, dadurch gekennzeichnet, daß das Abfragesignal mit einem Code entsprechend Daten moduliert ist, die in wenigstens einem der Transponder gespeichert sind.

27. Transponder zur Verwendung mit einem Interrogator nach Anspruch 24, dadurch gekennzeichnet, daß der Transponder gestaltet ist, um die Unterbrechung in dem Abfragesignal zu erfassen.

28. Transponder zur Verwendung mit einem Interrogator nach Anspruch 26, dadurch gekennzeichnet, daß der Transponder den Code in dem Abfragesignal bestimmt, und weiterhin dadurch gekennzeichnet, daß der Transponder ein Antwortsignal sendet, wenn der gesendete Code und die gespeicherten Daten einander entsprechen.

29. Transponder zur Verwendung in dem System nach einem der Ansprüche 1 bis 10.

30. Integrierte Schaltung zur Verwendung in einem Transponder mit einer Einrichtung zum Erzeugen eines Signales, abhängig von einem Abfragesignal, das Daten enthält, die den Transponder identifizieren, und einer Steuereinrichtung (38, 42), die angeordnet ist, um eine wiederholte Erzeugung des Antwortsignales zu veranlassen, dadurch gekennzeichnet, daß die integrierte Schaltung auf eine Unterbrechung in dem Abfragesignal anspricht.

31. Integrierte Schaltung nach Anspruch 30, dadurch gekennzeichnet, daß die Steuereinrichtung (42) auf die Unterbrechung in dem Abfragesignal anspricht, um eine Erzeugung des Antwortsignales zu beenden.

32. Integrierte Schaltung nach Anspruch 30, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um eine Unterbrechung des Abfragesignales für eine vorbestimmte Zeitdauer zu erfassen.

33. Integrierte Schaltung nach einem der Ansprüche 30 bis 32, mit einer Ladungsspeichereinrichtung (c), die angeordnet ist, um einen Teil der Energie des Abfragesignales zu speichern.

34. Integrierte Schaltung nach einem der Ansprüche 30 bis 33, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um das empfangene Abfragesignal auf einem vorbestimmten Code zu überwachen und um die Steuereinrichtung lediglich bei Empfang dieses Codes freizugeben.

35. Integrierte Schaltung nach einem der Ansprüche 30 bis 34, dadurch gekennzeichnet, daß die Steuereinrichtung (38, 42) gestaltet ist, um eine wiederholte Erzeugung des Antwortsignales zu vorbestimmten Intervallen zu veranlassen.

36. Integrierte Schaltung nach Anspruch 35, dadurch gekennzeichnet, daß die vorbestimmten Intervalle zufällig oder pseudo-zufällig in der Länge sind.

37. Integrierte Schaltung nach einem der Ansprüche 30 bis 35, dadurch gekennzeichnet, daß die Steuereinrichtung (42) gestaltet ist, um das empfangene Abfragesignal zu überwachen und um die Erzeugung des Antwortsignales nur nach einer Unterbrechung des Abfragesignales für eine vorbestimmte Zeitdauer freizugeben.

Revendications

1. Système d'identification comprenant un interrogateur et une pluralité de balises répondeuses, l'interrogateur comprenant des moyens formant émetteur (10) pour émettre un signal d'interrogation vers les balises répondeuses, des moyens formant récepteur (16, 18, 20, 22) pour recevoir des signaux de réponse des balises répondeuses, et des moyens formant processeur (28) pour identifier des balises répondeuses à partir de données dans les signaux de réponse ; chaque balise répondeuse comprenant une antenne réceptrice (30) pour recevoir le signal d'interrogation, un générateur de code (36), une antenne émettrice (32), et un modulateur (40) connecté au générateur de code, de telle sorte que, lors de la réception du signal d'interrogation, la balise répondeuse émette un signal de réponse contenant des données qui identifient la balise répondeuse, la balise répondeuse étant adaptée pour répéter l'émission du signal de réponse afin d'augmenter la probabilité d'une réception réussie de celui-ci par l'interrogateur, caractérisé en ce que l'interrogateur est adapté pour détecter une identification réussie de toute balise répondeuse et pour interrompre le signal d'interrogation afin d'indiquer une identification réussie.

2. Système d'identification selon la revendication 1, caractérisé en ce que chaque balise répondeuse comprend des moyens (38, 42) réagissant à une interruption respective du signal d'interrogation.

3. Système d'identification selon la revendication 2, caractérisé en ce que l'interrogateur est adapté pour interrompre le signal d'interrogation pendant une période prédéterminée après l'identification réussie d'une balise répondeuse particulière, cette balise répondeuse étant elle-même adaptée pour détecter l'interruption dans le signal d'interrogation et pour cesser l'émission de son signal de réponse en réponse à celle-ci.

4. Système d'identification selon la revendication 3, caractérisé en ce que la période prédéterminée pendant laquelle le signal d'interrogation est interrompu est plus courte que le signal de réponse de la balise répondeuse.

5. Système d'identification selon l'une quelconque des revendications 1 à 4, caractérisé en ce que la balise répondeuse comprend des moyens de commande (42) pour commander l'émission du signal de réponse, les moyens de commande étant adaptés pour provoquer des émissions répétées des signaux de réponse à intervalles prédéterminés.

6. Système d'identification selon la revendication 5, caractérisé en ce que les intervalles prédéterminés sont de longueur aléatoire ou pseudo-aléatoire.

7. Système d'identification selon la revendication 6, caractérisé en ce que la longueur des intervalles aléatoires ou pseudo-aléatoires est dérivée de données identifiant la balise répondeuse.

8. Système d'identification selon l'une quelconque des revendications 1 à 7, caractérisé en ce que l'interrogateur est adapté pour émettre un code identifiant une balise répondeuse ou une catégorie de balises répondeuses prédéterminée, chaque balise répondeuse comprenant des circuits (42) pour valider la balise répondeuse uniquement lors de la réception du code correspondant à celle-ci.

9. Système d'identification selon l'une quelconque des revendications 1 à 8, caractérisé en ce que le modulateur (40) de chaque balise répondeuse est configuré pour dévier une partie de l'énergie du signal d'interrogation reçu vers l'antenne émettrice, de telle sorte que, lors de la réception du signal d'interrogation, la balise répondeuse émette un signal de réponse comprenant une porteuse dérivée du signal d'interrogation qui est modulée par la sortie du générateur de code (36).

10. Système d'identification selon la revendication 9, caractérisé en ce que l'interrogateur comprend un mélangeur (20) pour mélanger un signal de référence dérivé du signal d'interrogation au signal de réponse reçu de la balise répondeuse, et des moyens formant filtre (22) pour extraire un signal de différence de la sortie du mélangeur qui contient les données du signal de réponse.

11. Balise répondeuse comprenant une antenne réceptrice (30) pour recevoir un signal d'interrogation, un générateur de code (36), une antenne émettrice (32), et un modulateur (40) connecté au générateur de code, la balise répondeuse étant adaptée pour émettre un signal de réponse contenant des données qui identifient la balise répondeuse, la balise répondeuse comprenant des moyens de commande (38, 42) configurés pour provoquer l'émission répétée du signal de réponse afin d'augmenter la probabilité d'une réception réussie de celui-ci par l'interrogateur, caractérisée en ce que la balise répondeuse réagit à une interruption du signal d'interrogation.

12. Balise répondeuse selon la revendication 11, caractérisée en ce que les moyens de commande (42) réagissent à l'interruption du signal d'interrogation en cessant l'émission du signal de réponse.

13. Balise répondeuse selon la revendication 11 ou la revendication 12, caractérisée en ce que le modulateur (40) est configuré pour dévier une partie de l'énergie du signal d'interrogation reçu vers l'antenne émettrice (32), de telle sorte que, lors de la réception du signal d'interrogation, la balise répondeuse émette un signal de réponse comprenant une porteuse dérivée du signal d'interrogation qui est modulée par la sortie du générateur de code (36).

14. Balise répondeuse selon la revendication 12 ou la revendication 13, caractérisée en ce que les moyens de commande (38, 42) sont configurés pour contrôler le signal d'interrogation reçu et pour invalider le modulateur (40) lors de la réception d'un signal de confirmation prédéterminé de l'interrogateur, qui est reçu après la réception réussie du signal de réponse par l'interrogateur.

15. Balise répondeuse selon la revendication 14, caractérisée en ce que les moyens de commande (42) sont adaptés pour détecter une interruption du signal d'interrogation d'une période prédéterminée.

16. Balise répondeuse selon l'une quelconque des revendications 11 à 15, comprenant des moyens de stockage de charge (c) configurés pour stocker une partie de l'énergie du signal d'interrogation, le générateur de code (36) au moins étant configuré pour être alimenté par les moyens de stockage de charge lors du fonctionnement.

17. Balise répondeuse selon l'une quelconque des revendications 14 à 16, caractérisée en ce que les moyens de commande (42) sont adaptés pour contrôler le signal d'interrogation reçu en ce qui concerne un code prédéterminé, et pour valider le modulateur (40) uniquement lors de la réception de ce code.

18. Balise répondeuse selon l'une quelconque des revendications 11 à 17, caractérisée en ce qu'au moins l'une des antennes réceptrice et émettrice (30, 32) est formée sur un substrat auquel est appliquée la balise répondeuse.

19. Balise répondeuse selon la revendication 18, caractérisée en ce qu'au moins une antenne (30, 32) est formée en réalisant une impression sur le substrat à l'aide d'un matériau conducteur.

20. Balise répondeuse selon l'une quelconque des revendications 11 à 19, caractérisée en ce que les moyens de commande (38, 42) sont adaptés pour provoquer l'émission répétée du signal de réponse à intervalles prédéterminés.

21. Balise répondeuse selon la revendication 20, caractérisée en ce que les intervalles prédéterminés sont de longueur

aléatoire ou pseudo-aléatoire.

22. Balise répondeuse selon la revendication 21, caractérisée en ce que la longueur des intervalles aléatoires ou pseudo-aléatoires est dérivée des données identifiant la balise répondeuse.

23. Balise répondeuse selon l'une quelconque des revendications 11 à 22, caractérisée en ce que les moyens de commande (42) sont adaptés pour contrôler le signal d'interrogation reçu et pour valider l'émission du signal de réponse uniquement après une interruption du signal d'interrogation pendant une durée prédéterminée.

24. Interrogateur pour identifier une pluralité de balises répondeuses comprenant des moyens formant émetteur (10) pour émettre un signal d'interrogation vers les balises répondeuses, des moyens formant récepteur (16, 18, 20, 22) pour recevoir des signaux de réponse des balises répondeuses, et des moyens formant processeur (28) pour identifier une balise répondeuse à partir de données dans le signal de réponse, caractérisé en ce que l'interrogateur est adapté pour interrompre le signal d'interrogation afin d'indiquer une identification réussie

25. Interrogateur selon la revendication 24, caractérisé en ce que l'interrogateur est adapté pour interrompre le signal d'interrogation pendant un temps prédéterminé après l'identification réussie d'une balise répondeuse.

26. Interrogateur selon la revendication 24, caractérisé en ce que le signal d'interrogation est modulé par un code correspondant à des données mémorisées dans au moins l'une des balises répondeuses.

27. Balise répondeuse destinée à être utilisée avec un interrogateur selon la revendication 24, caractérisée en ce que la balise répondeuse est adaptée pour détecter l'interruption du signal d'interrogation.

28. Balise répondeuse destinée à être utilisée avec un interrogateur selon la revendication 26, caractérisée en ce que la balise répondeuse détermine le code dans le signal d'interrogation, et caractérisée de plus en ce que la balise répondeuse émet un signal de réponse si le code émis et les données mémorisées correspondent.

29. Balise répondeuse destinée à être utilisée dans le système selon l'une quelconque des revendications 1 à 10.

30. Circuit intégré destiné à être utilisé dans une balise répondeuse, comprenant des moyens pour produire un signal, en réponse à un signal d'interrogation, contenant des données qui identifient la balise répondeuse, et des moyens de commande (38, 42) configurés de façon à provoquer la production répétée du signal de réponse, caractérisé en ce que le circuit intégré réagit à une interruption du signal d'interrogation.

31. Circuit intégré selon la revendication 30, caractérisé en ce que les moyens de commande (42) réagissent à l'interruption du signal d'interrogation en cessant la production du signal de réponse.

32. Circuit intégré selon la revendication 30, caractérisé en ce que les moyens de commande (42) sont adaptés pour détecter une interruption du signal d'interrogation d'une période prédéterminée.

33. Circuit intégré selon l'une quelconque des revendications 30 à 32, comprenant des moyens de stockage de charge (c) configurés pour stocker une partie de l'énergie du signal d'interrogation.

34. Circuit intégré selon l'une quelconque des revendications 30 à 33, caractérisé en ce que les moyens de commande (42) sont adaptés pour contrôler le signal d'interrogation reçu en ce qui concerne un code prédéterminé, et pour valider les moyens de commande uniquement lors de la réception de ce code.

35. Circuit intégré selon l'une quelconque des revendications 30 à 34, caractérisé en ce que les moyens de commande (38, 42) sont adaptés pour provoquer la production répétée du signal de réponse à intervalles prédéterminés.

36. Circuit intégré selon la revendication 35, caractérisé en ce que les intervalles prédéterminés sont de longueur aléatoire ou pseudo-aléatoire.

37. Circuit intégré selon l'une quelconque des revendications 30 à 34, caractérisé en ce que les moyens de commande (42) sont adaptés pour contrôler le signal d'interrogation reçu et pour valider la production du signal de réponse uniquement après une interruption du signal d'interrogation pendant une durée prédéterminée.

Fig. 1

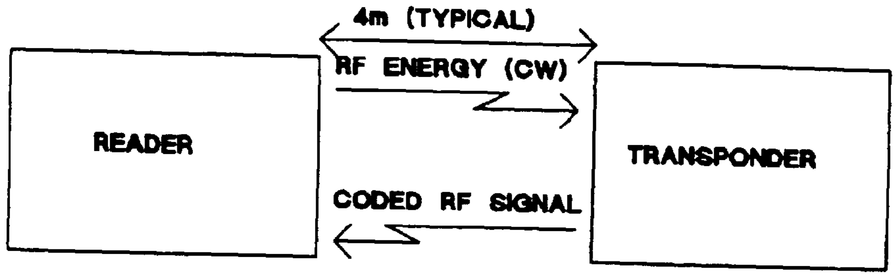
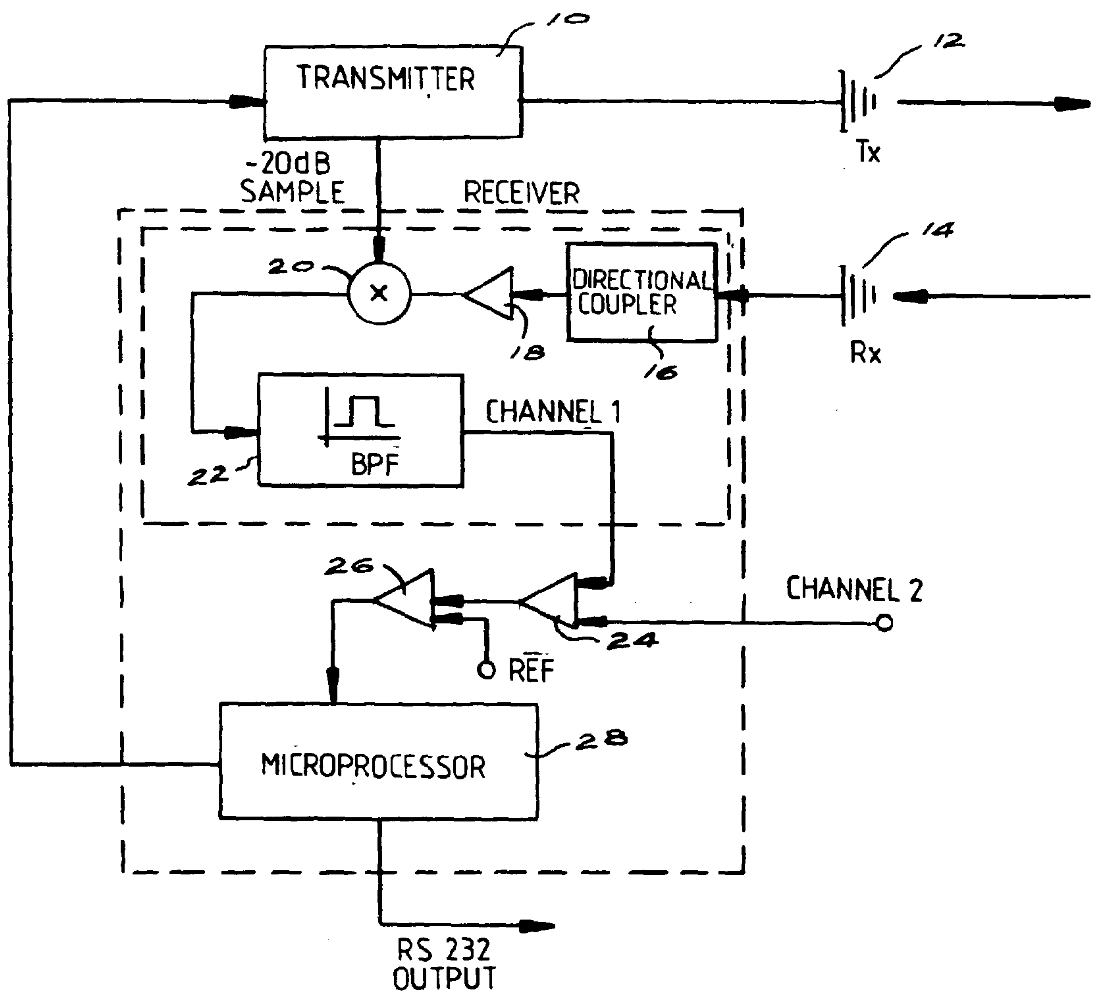

4m (TYPICAL)
RF ENERGY (CW)
READER
TRANSPONDER
CODED RF SIGNAL

Fig. 2


10
TRANSMITTER
12
Tx
-20dB
SAMPLE
RECEIVER
14
20
DIRECTIONAL
COUPLER
Rx
18
16
CHANNEL 1
BPF
22
26
CHANNEL 2
24
REF
28
MICROPROCESSOR
RS 232
OUTPUT

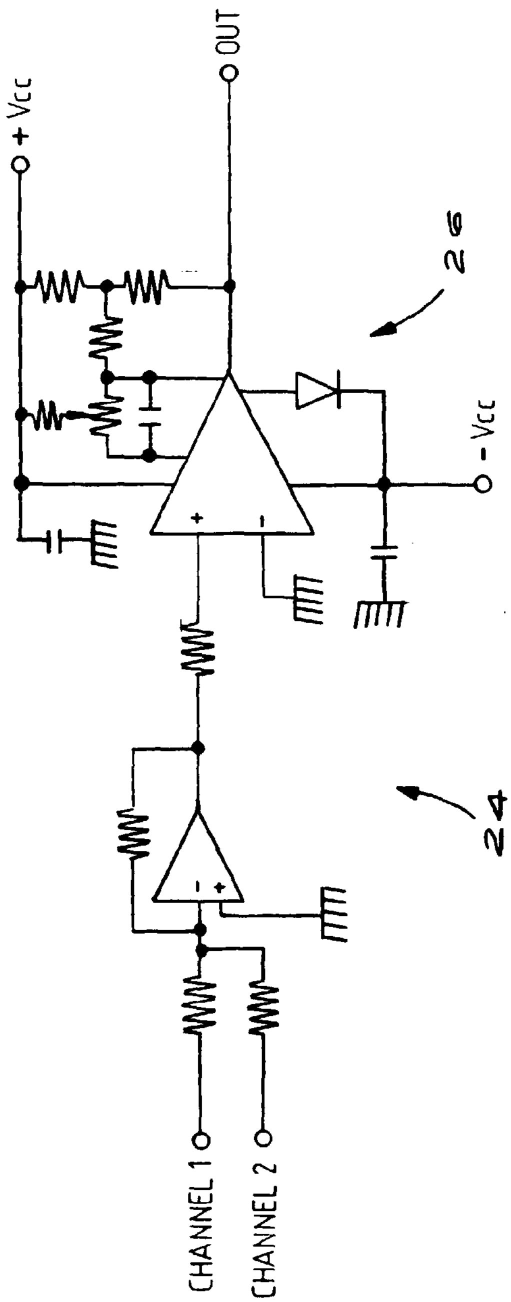


FIG. 3

FIG 4

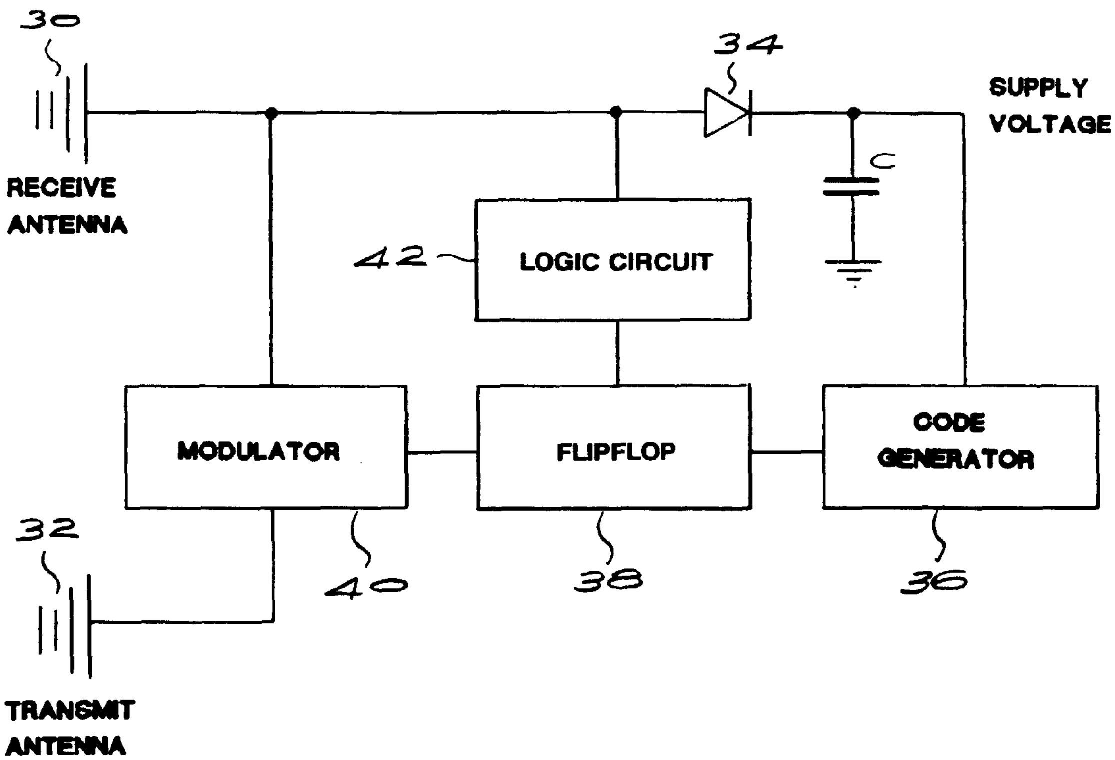
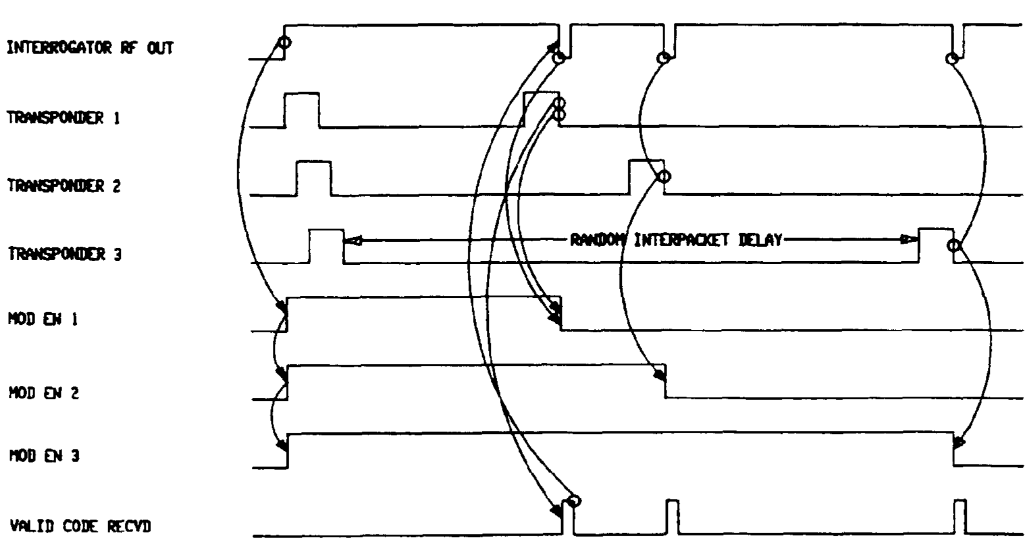

30
34
SUPPLY
VOLTAGE
RECEIVE
ANTENNA
C
42
LOGIC CIRCUIT
MODULATOR
FLIPFLOP
CODE
GENERATOR
32
40
38
36
TRANSMIT
ANTENNA

FIG 5


INTERROGATOR RF OUT
TRANSPONDER 1
TRANSPONDER 2
TRANSPONDER 3
RANDOM INTERPACKET DELAY
MOD EN 1
MOD EN 2
MOD EN 3
VALID CODE RECVD

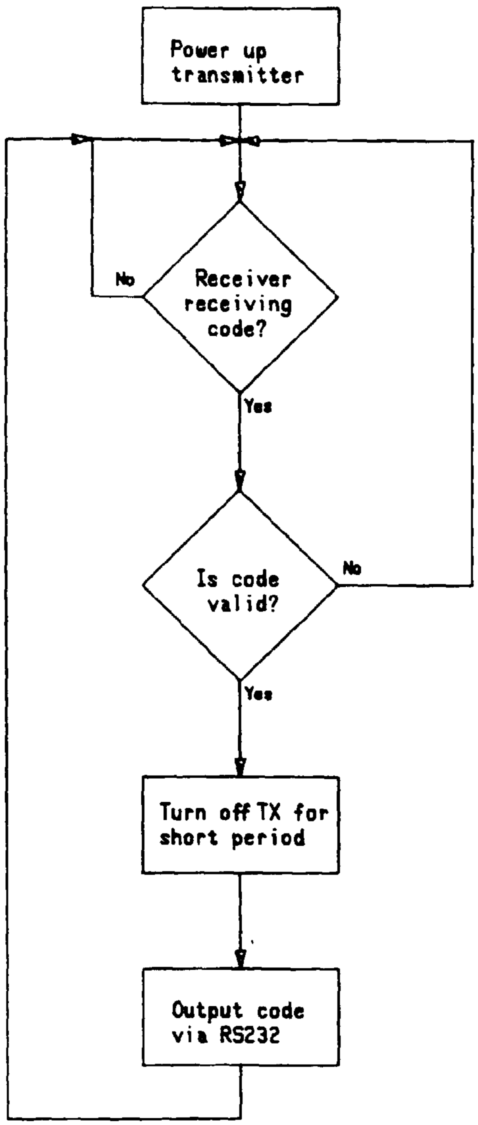

Power up transmitter
Receiver receiving code?
No
Yes
Is code valid?
No
Yes
Turn off TX for short period
Output code via RS232

FIG 6

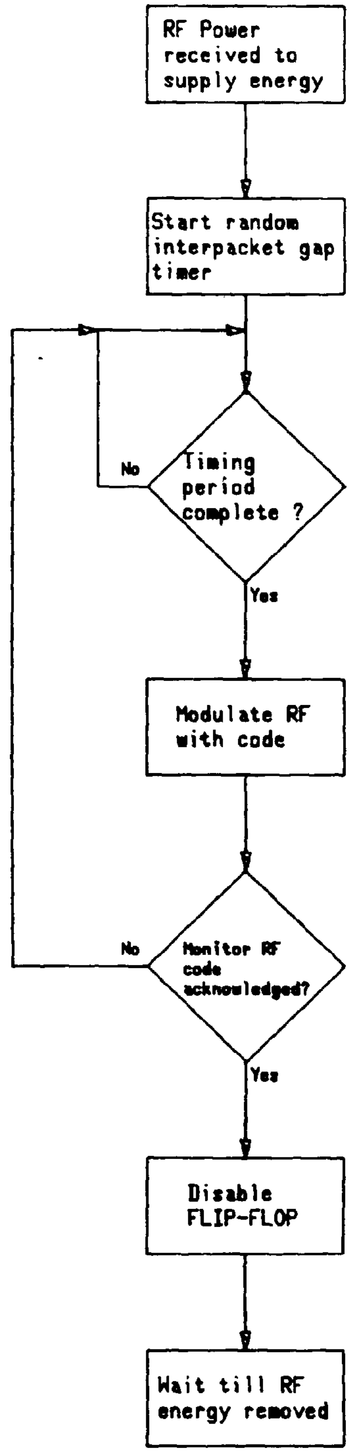

RF Power received to supply energy
Start random interpacket gap timer
Timing period complete ?
No
Yes
Modulate RF with code
Monitor RF code acknowledged?
No
Yes
Disable FLIP-FLOP
Wait till RF energy removed

FIG 7

FIG 8

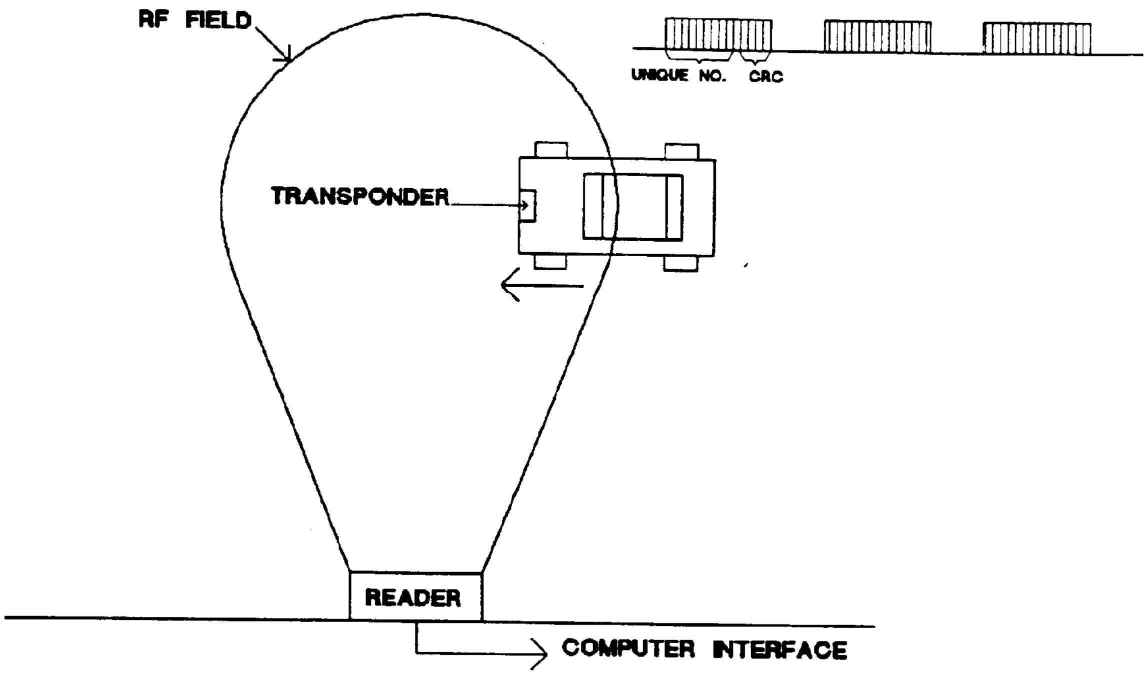
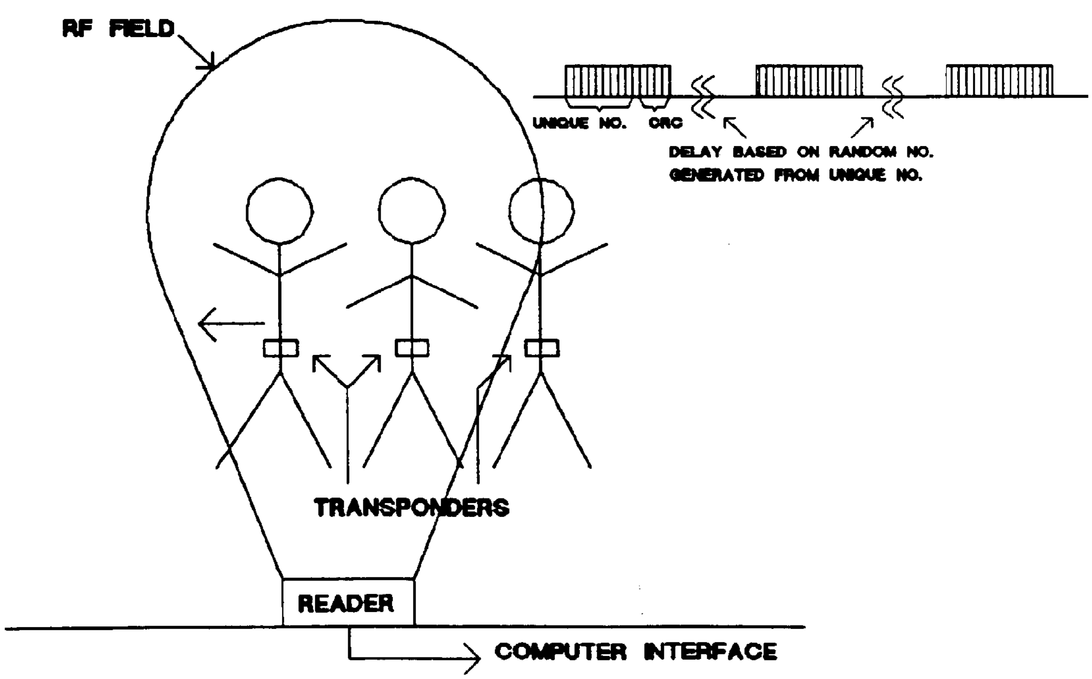

RF FIELD
UNIQUE NO.
CRC
TRANSPONDER
READER
COMPUTER INTERFACE

FIG 9


RF FIELD
UNIQUE NO.
CRC
DELAY BASED ON RANDOM NO.
GENERATED FROM UNIQUE NO.
TRANSPONDERS
READER
COMPUTER INTERFACE

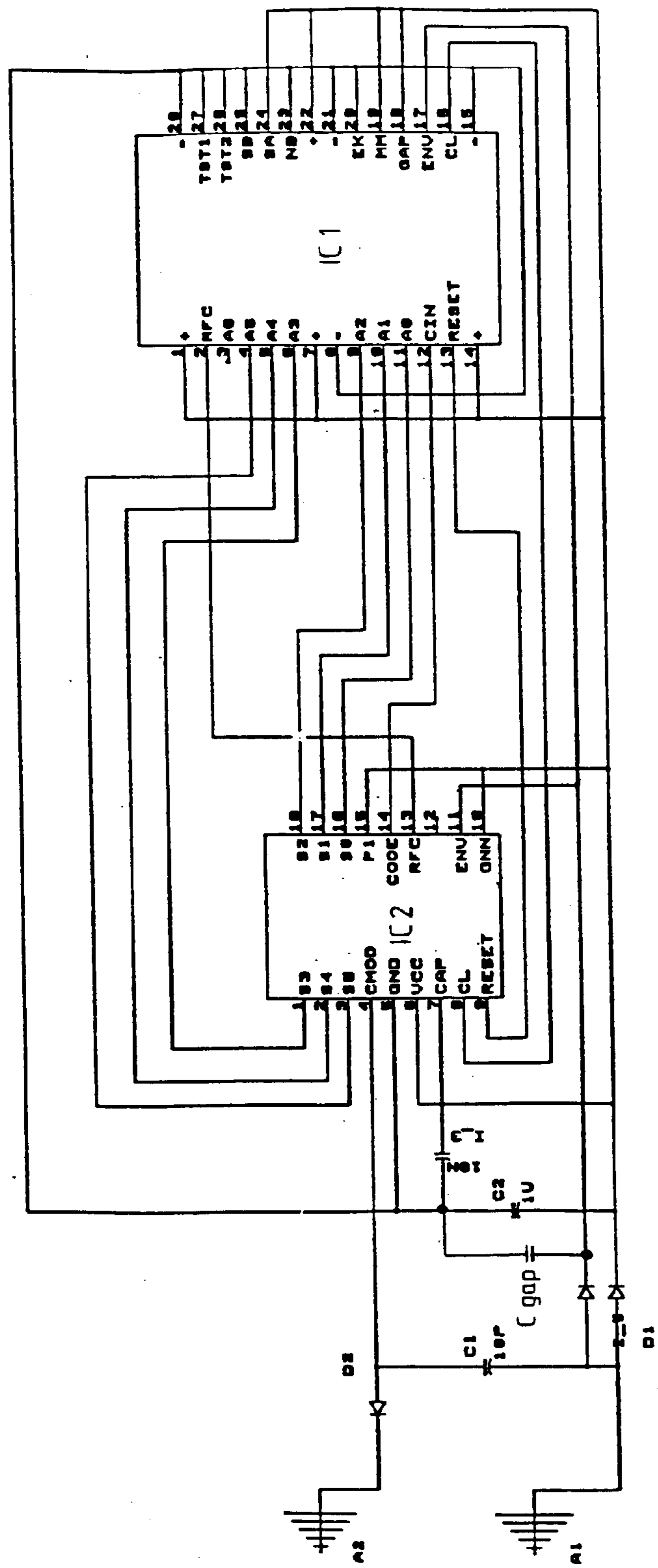
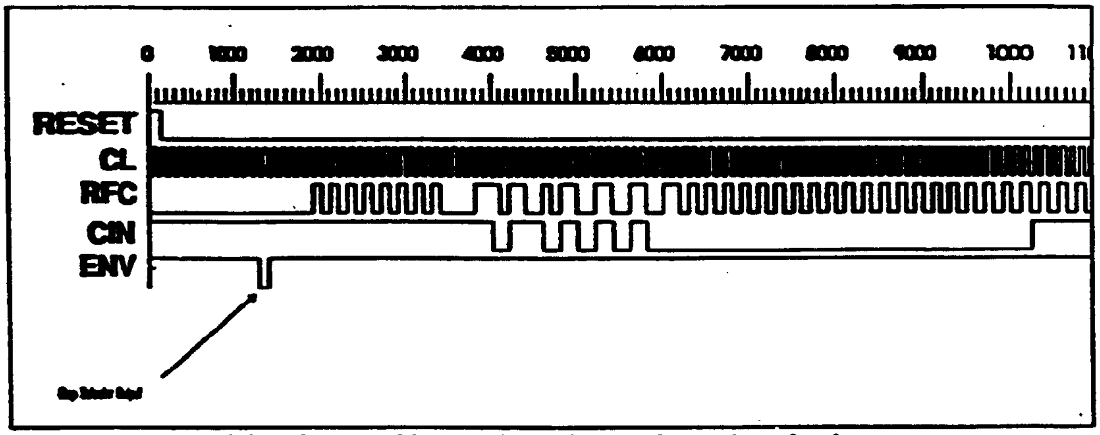
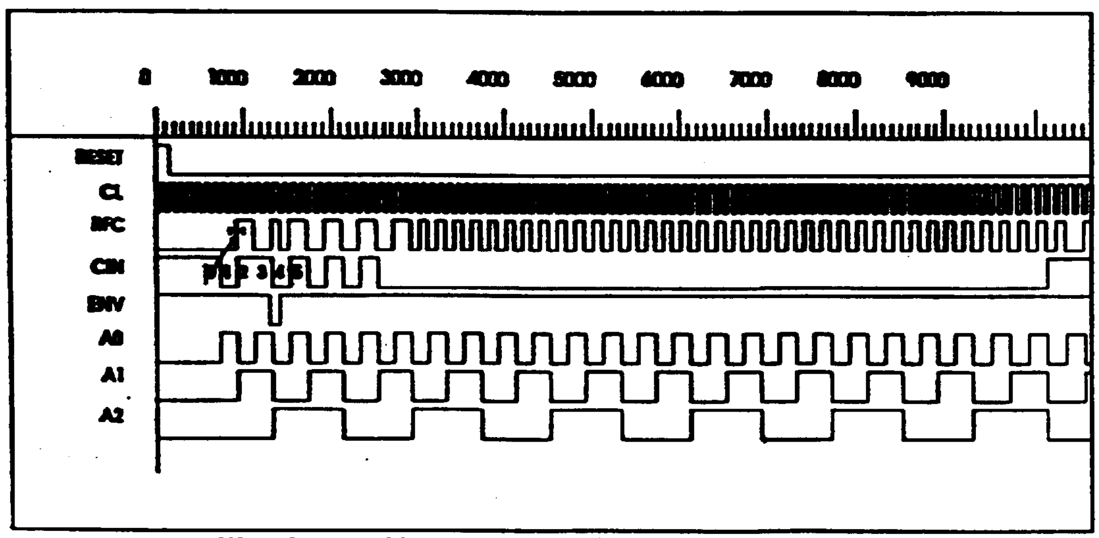

IC1
IC2
TST1
TST2
GAP
ENV
CL
CIN
RESET
RFC
CODE
CMOD
GND
VCC
CAP
C gap
C1
C2
D1
D2
A1
A2

FIG. 11



Waveforms with gap detection and synchronization

FIG /2



Waveforms with no gap detection or synchronization

FIG /3

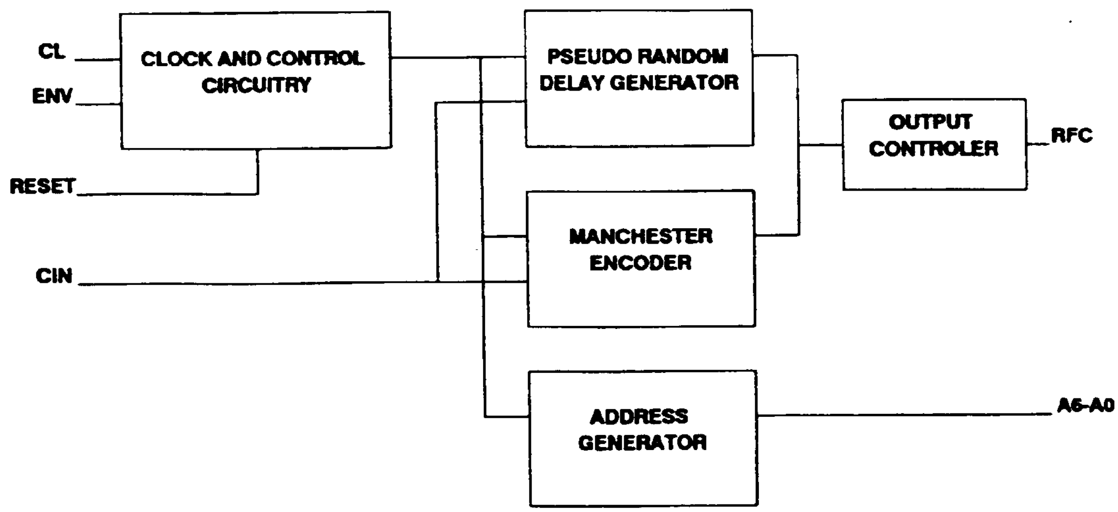


FIG 10

SB	SA	Max. slots between transmissions
0	0	0
0	1	16
1	0	128
1	1	1024

FIG 14